A MODEL FOR PREDICTING THE ENERGY PERFORMANCE OF EXISTING BUILDINGS UPGRADED WITH SUSTAINABLE TECHNOLOGIES

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BSc (Hons), MCPM (Thesis)

A thesis submitted in partial fulfilment of the requirements of the University of Technology Sydney for the degree of Doctor of Philosophy

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, John Dadzie, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy in the Faculty of Design, Architecture, and Building at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Candidate: ………………………………………..……

Date: ………………………………………………………………

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DEDICATION

This thesis is dedicated to God, my mentor Prophet T.B. Joshua, my extended family and generations yet unborn.

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ABSTRACT

The impact of existing buildings on the environment is increasing. There is the need to realign and focus on achieving true sustainability that considers sustainable technologies for built facilities. However, these technologies with varying functions become outdated over time, thus there is the need to upgrade to match new energy efficiency benchmarks. The sustainable upgrade of existing buildings adopts sustainable technologies to reduce the impact of high energy consumption and greenhouse gas emissions. This thesis develops a predictive model to estimate energy consumption of existing buildings upgraded with sustainable technologies. The study investigates the types of sustainable technologies, and the relationship between sustainable technologies and building age, and variables impacting energy consumption of existing buildings. A literature review of the need for sustainable development to curb the increasing impact of existing buildings on the environment, including the nature of existing buildings, types of sustainable renovation and related energy savings, drivers of sustainable upgrade, sustainable technologies and barriers to the adoption and application of sustainable technologies is followed by a review of tools used to predict energy consumption of existing buildings improved with sustainable technologies. A conceptual framework for sustainable upgrade is developed to present the determinants of existing buildings and sustainable technologies in predicting the energy consumption through sustainable upgrade. The methodology is a mixed method approach including a questionnaire with in–built case study, interviews and verification through case study.

The findings indicate that sustainable technologies adopted to improve existing buildings are less expensive, leading to less energy reduction. Also, sustainable technologies required to improve energy savings only target fairly new buildings with a majority of old buildings not receiving the same investment. The main variables identified as contributing to energy consumption in existing buildings are building size, window area, area of external wall, number of occupants, U–value of ceiling and walls, thickness of insulation and lifespan of sustainable technologies. The main energy saving technologies are lighting technologies, HVAC, renewable energy technologies, envelope technologies, sustainable HVAC equipment and passive technologies. The predictive model combines the main determinants into an energy efficient decision tool to support sustainable upgrade of existing buildings. It makes it possible to calculate expected energy savings from upgrades of existing buildings with sustainable technologies, presenting a clear direction for energy savings which ultimately also translate into cost savings.